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TECHNICAL PROGRESS REPORT #3

A compact programmable laser Doppler velocimeter for marine applications

Contract Number 90-C-0105

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Introduction

The three major tasks conducted during this period are the completion of the construction of a small water test section, the testing of the electronic processor, and the successful acquisition of single and two-velocity component LDV data. The test section consists of a rectangular Plexiglass section with a nozzle on one end and an extraction orifice on the other. A recirculating pump and flexible tubing are used to draw water from a reservoir, flow it though the test section and return it to the reservoir. Polystyrene particles of 10 μm in diameter were seeded into the flow. The laser beams were oriented to measure both the horizontal and vertical velocity components. The test section could be oriented at arbitrary angles to the incoming laser beams to produce flows at arbitrary directions.

Discussion

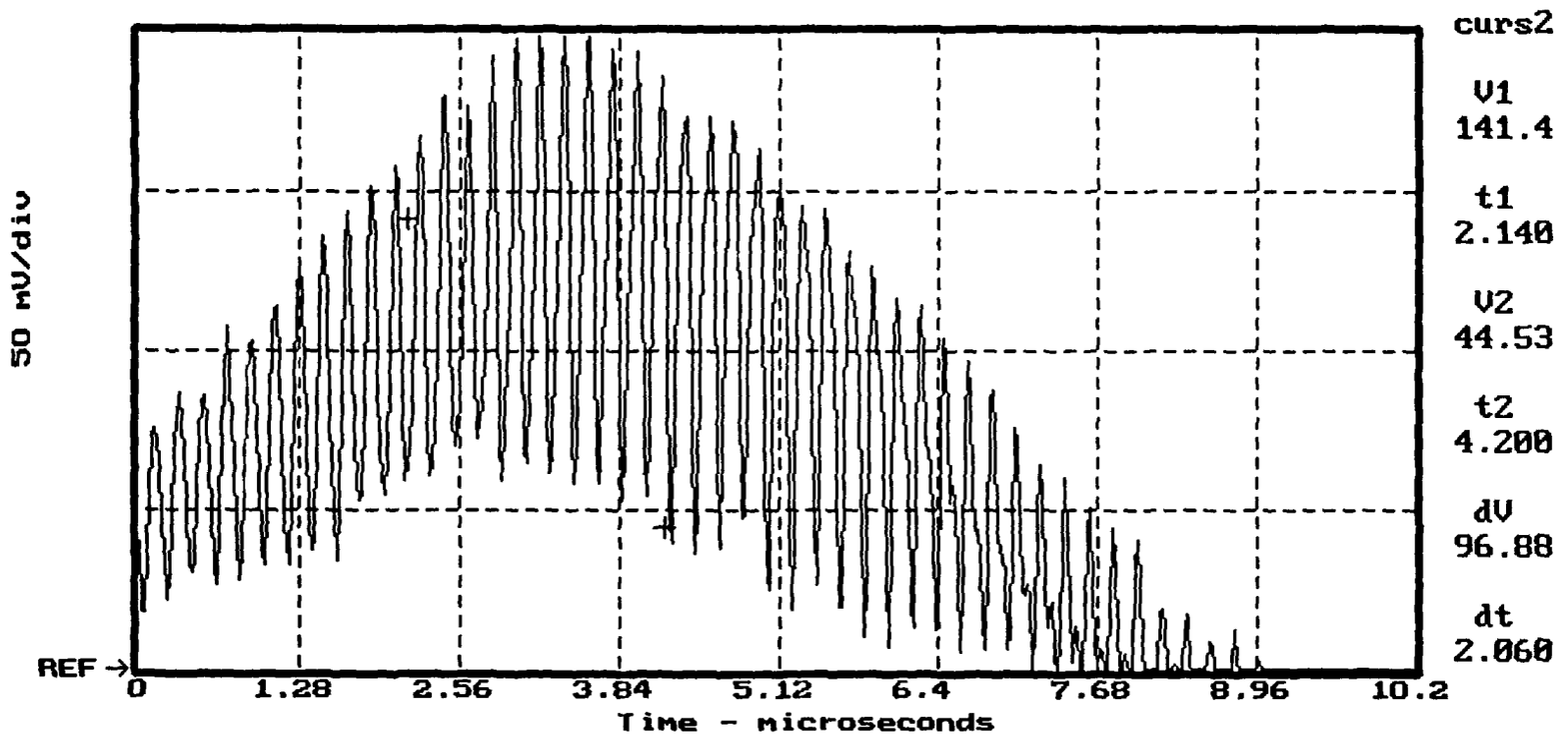
The system uses a 40 mW diode laser operating at 805 nm, three Bragg cells which provide frequency shifting, and a programmable digital signal processor (DSP) which will lead to a autonomous system capable of intelligent decisions. For stationary particles, the horizontal velocity component has a frequency shift (fs_1) of 5 MHz and the vertical velocity component has a frequency shift (fs_2) of 10 MHz. Thus, when the particles move due to flow velocity, the processed frequencies would be:

$$f_1 = fs_1 \pm U/\delta_1, \quad (1)$$

$$f_2 = fs_2 \pm V/\delta_2, \quad (2)$$

where f_1 and f_2 are the processed frequencies, δ_1 and δ_2 are the fringe spacings, and U and V are the velocity components in the horizontal and vertical directions. The values of δ_1 and δ_2 are 28 μm and 25 μm respectively.

The two enclosed graphs show the processed frequency both in the time domain and the frequency domain. The frequency spectrum was obtained by performing an FFT on the collected data. Notice the values of f_1 = 5.225 MHz and f_2 = 10.25 MHz. Substituting these values into equations (1) and (2), we arrive with velocity values of U = V = 6.2 m/s. In this particular example the U and V components are equal and correspond to flow moving at 45 degrees. In general, U and V can have arbitrary values. This arrangement permits the measurement of flow velocity and turbulence at arbitrary directions; including recirculating flows.



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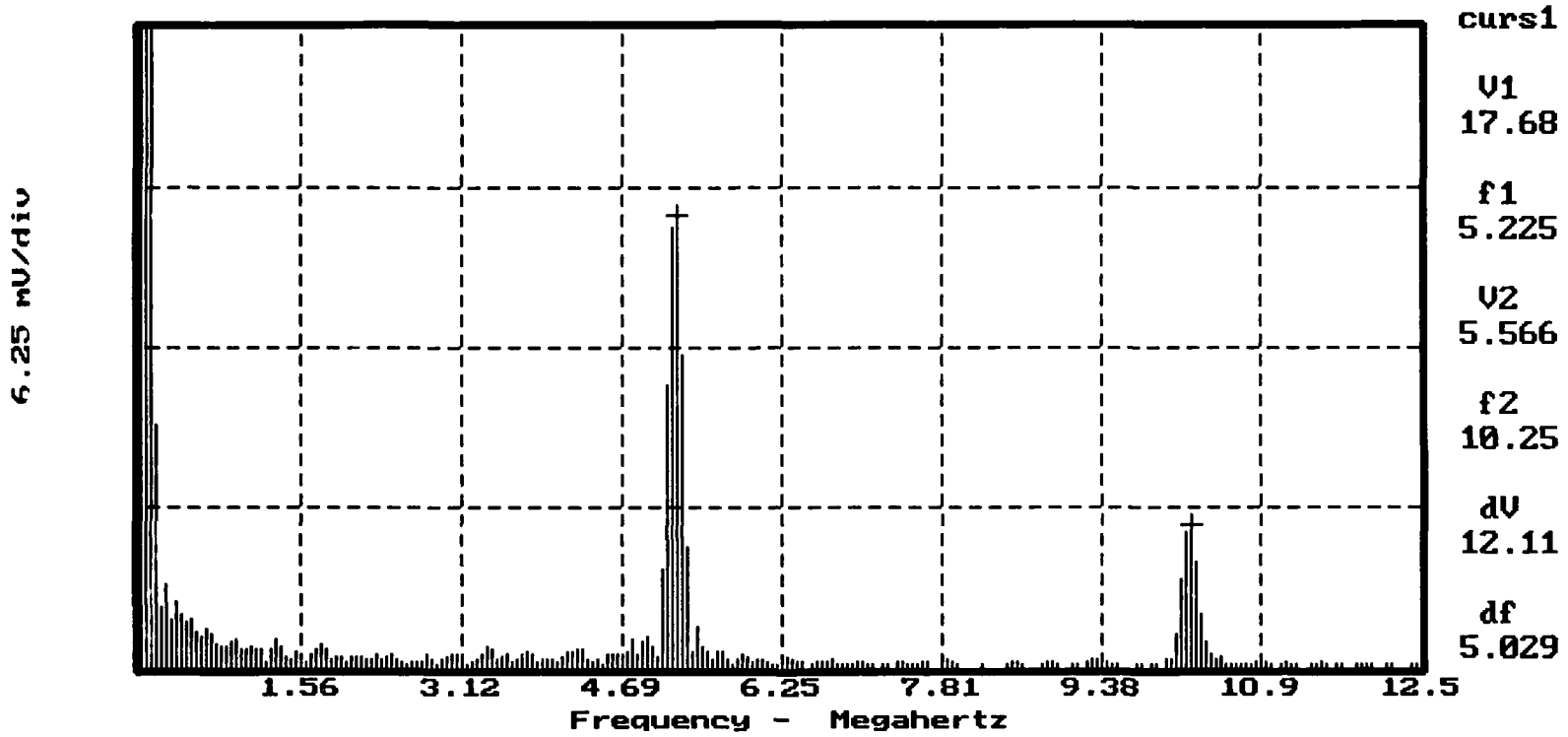

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